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From social and natural vulnerability to human-centered climate resilient coastal cities

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Anthropogenic climate change is increasingly affecting every city in the world, including through more intense weather and climate extremes. Climate impacts and risks are magnified in cities, which are home to more than half the world's population. Projections show one billion people will live in areas at risk of coastal hazards by 2050. Sea level rise jeopardizes cities to complicated wind, water, and coastal hazards. Potential impacts on wellbeing include damage to housing, transportation, and energy infrastructure as well as human health. Yet, attention thus far has focused on incremental adaptation responses, with a focus more on infrastructure and technology transitions in coastal cities. Comprehensive transformative actions that specifically incorporate behavioral, cultural and institutional options are largely neglected. In this perspective, we emphasize that immediate and massive effort and involvement from individuals to social entities across sectors, institutions, and systems is required for a transformation toward climate-resilient coastal cities. We conclude by emphasizing that dichotomies between ambitious adaptation and mitigation actions need to be bridged to enhance resilience to warming in coastal cities, and that this requires appropriate multi-level governance mechanisms to coordinate across agents and sectors.

KEYWORDS

climate change adaptation, climate change mitigation, multi-level governance, behavioral change, human wellbeing

Social and natural vulnerability

From time immemorial, coastal cities have attracted large and growing concentrations of human populations. Today about 40% of the world's population lives in coastal cities (UNESCO, 2011). It is also estimated that there are over 2,000 coastal city agglomerations with over 100,000 inhabitants (Barragán and de Andrés, 2015). While these cities offer vital livelihood, productive and employment opportunities, especially in marine and ocean-related activities, they are also increasingly vulnerable to complex hazards, both natural and anthropogenic. In recent decades, climate-related hazards, in particular, have accelerated in frequency and intensity (IPCC., 2022). Consequently, populations in coastal cities are increasingly under threat, specifically socially vulnerable populations in these cities bear a disproportionately large proportion of losses from extreme events and have a lower capacity to recover and adapt (Berke et al., 2019; Howell and Elliott, 2019).

A characteristic common to coastal cities in the last decades has been rapid expansion that has accompanied general urbanization trends globally. This expansion has placed significant pressure on basic infrastructures, assets and essential services within these cities, particularly in the Global South. The vulnerability of populations in coastal cities in both the Global North and South is caused by a combination of hazard exposure, socioeconomic status, lack of adequate physical infrastructures, as well as limited institutional and governance capacity (Le, 2020). High population densities, unplanned and *ad hoc* settlement

expansion and large inequalities in access to decent living standards (Rao and Min, 2018) are particular challenges for coastal cities in the Global South. A vast literature on assessing the causes, extent and consequences of coastal populations' vulnerability has emerged in recent years (Filho et al., 2019; Thomas et al., 2019; Bukvic et al., 2020; Rangel-Buitrago et al., 2020). However, less is understood about opportunities for rapidly increasing these regions and populations' resilience and adaptive capacity.

In the following, we provide a perspective on essential elements that need to be considered in an integrated way to enable a human-centered just, resilient and sustainable future for coastal city inhabitants. We illustrate the importance of these by means of selected examples from the literature showcasing best practices where and how such efforts have enabled a shift to more resilient planning and transformative adaptation in coastal cities. We then conclude by highlighting some research gaps and recommendations on important considerations to advance efforts to improve resilience and enhance the adaptability and sustainability of coastal cities.

Turning challenges into opportunities

Despite the many challenges faced by coastal cities, these cities offer huge opportunities to their inhabitants and can be centers of innovation and change to new and more sustainable ways of living. Cities consist of complex social systems of urban services, including housing, transport, food, health, jobs and energy, all of which are linked to ecosystem services. Thus, an integrated systems approach is needed to understand this complex system and its dynamics and feedbacks.

Several (urban) resilience studies have developed conceptual frameworks and identified key elements for accounting for such feedbacks (Folke, 2006; Tyler and Moench, 2012; Brown, 2014; Torabi et al., 2018; Meerow and Newell, 2019). Research by Alberti et al. (2003), for example, proposes an integrated model to understand forces driving urban development patterns, how these patterns influence biophysical and human processes, and the resulting environmental changes and feedback on human and biophysical drivers. Three main elements that are consistently identified in several of the proposed frameworks include; (a) human system, (b) ecosystem and services, and (c) governance. Several studies examine the relationship between human and ecosystem/services and their impacts on human wellbeing. For example, there are studies that focus on the role of biodiversity and green spaces in cities (Ekkel and de Vries, 2017; Aram et al., 2019; Patiño, 2020; Anderson et al., 2022), service provisioning and infrastructure (Žlender and Ward Thompson, 2017; Duy et al., 2019; Miguez et al., 2019; Sharifi, 2022). Other studies focus on how social aspects (e.g., inequity) link to governance (Ziervogel and Taylor, 2008; Berke et al., 2019; Fraser, 2022; Wu et al., 2022). However, there is relatively little literature that takes a comprehensive view examining all three elements (human system, ecosystem and governance) together, and transformations that bridge the adaptation and mitigation divide are largely overlooked. Building on this insight, we distinguish between three layers of elements, namely agents, systems, and institutions, to characterize the dynamics of a transition to low-carbon, climate-resilient, high human wellbeing and just coastal cities. In the following, we discuss the importance of these in turn (see Figure 1).

Human: Agents of change

Actors can be (i) individuals and households whose personal decisions and actions (as consumers, prosumers, citizens) impact products/services/energy and resources; (ii) civil society, non-governmental organizations (NGOs), and social movements; and (iii) business firms, the financial sector, and professional organizations, who shape and incentivize technological and social innovation and the behavior of professional actors (Roy et al., 2012; Creutzig et al., 2022b). Transformation to climate-resilient cities requires a massive effort by all agents, from individuals to social entities.

Individual differences in climate risk perception and motivation to change behavior suggest the need for segmentation in the way different individuals or groups are targeted in information or climate action campaigns, with age, education, political values, and personal experience being important segmentation variables. **Collective action** by individuals as part of formal social movements or informal lifestyle change can significantly impact climate mitigation and adaptation. Movements that shift social norms can produce tipping points toward new lifestyles (Niamir et al., 2020; Otto et al., 2020). **Community initiatives** involve collective action by civil society, typically local residents and community groups. Such initiatives can help with climate mitigation to improve energy efficiency, shifts to renewable energy and to reduce fuel poverty through collective ownership, benefit and control over decision-making. They are also important for climate adaptation to create opportunities for expanding existing skills among participants, e.g., leadership, finance, management as well as knowledge. In addition, communities of building managers, landlords, energy advisers, technology installers and car dealers influence patterns of mobility and shelter and the associated energy consumption by acting as **middle actors** in the provision of services. **Business firms**, financial markets, insurance agencies, and professionals and their organizations also have a role to play in climate change mitigation and adaptation and enhancing resilience. To achieve climate-resilient cities equitably, social change, addressing social practices and ways of organizing and challenging dominant norms and beliefs, is needed. Social innovation, whereby new combinations of social practices, which cope with human needs and problems better than existing practices, offers novel approaches to ecological crises that differ from traditional technology-based solutions and demonstrates the relevance of sustainable behavioral and lifestyle changes (Mont et al., 2014; Pel et al., 2020; Haskell et al., 2021).

Examples in the literature that explore the role such actors have played in a transition to more climate-resilient coastal cities include an empirical investigation of variations in factors shaping households' adaptations to flooding, the costliest hazard worldwide (Noll et al., 2022). The authors of this work discuss how social influence, worry, climate change beliefs, self-efficacy, and perceived costs exhibit universal effects on household adaptations, despite contextual differences. Thus, they argue that to see

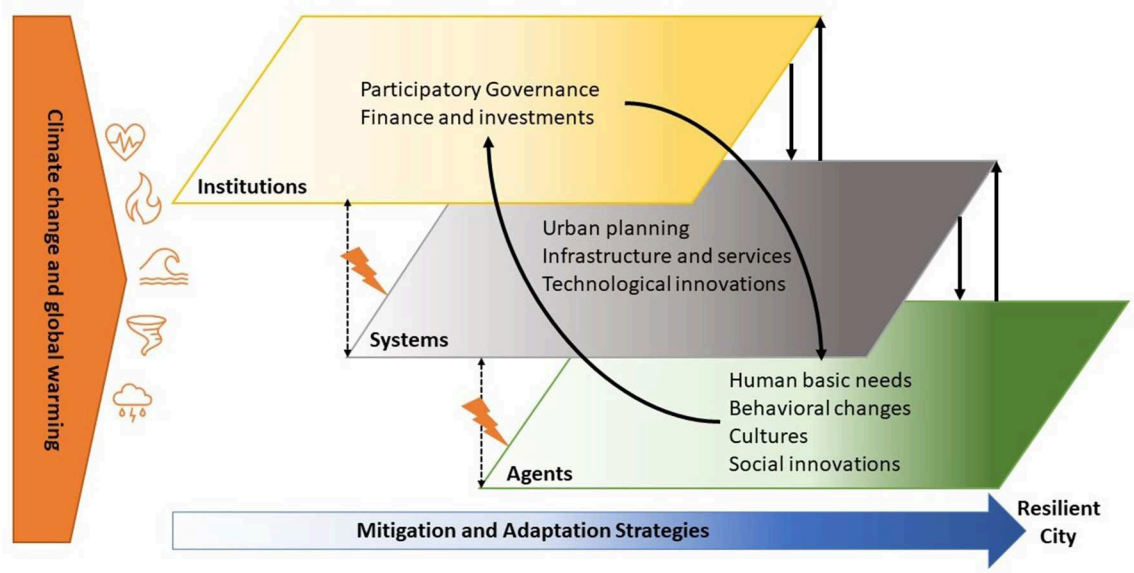

FIGURE 1
Transition to a climate resilient city, an integrated systems approach.

prompt household adaptation behavior, personalized narratives should complement the communication of climate-driven risks. Other work has explored the potential of social innovation and its relation to individual behavioral change and governance to transform urban green spaces in Groningen and London (Spijker and Parra, 2018). This study concluded that social innovations can have various positive impacts on the urban landscape and human wellbeing, empower people in their quest for new values in urban space, turn neglected spots into places with meaning, and connect the individual with the urban. Thus a transition to climate-resilient coastal cities requires a focus on multi-actor governance and collaboration, often with a focus on citizens and inclusion of grassroots initiatives, both through bottom-up and top-down processes and their combinations (see also the section on institutions).

Systems and services

Urban planning and design

Among the many important components of urban design, green spaces are one way to significantly increase the resilience of cities to heatwaves, floods, landslides, and even coastal erosion while enhancing sustainability and human wellbeing by improving air quality, protecting biodiversity, and absorbing carbon (Ekkel and de Vries, 2017; Creutzig et al., 2022a). Sustainable Development Goal (SDG) 11 recognizes the importance of accessibility to urban green space for all population groups, regardless of income, gender, age, or ethnicity. The WHO also advocates for universal access to green space, and more specifically, that every urban dweller should live within 300 meters (linear distance) of green space or less than a 5-min walk. Living in or with easy access to green space can provide important mental and physical health benefits.

In many cities, however, public and green infrastructure is more abundant and accessible in high-income areas than in low-income areas, particularly in middle and low-income countries (Wolch et al., 2014; Chen et al., 2020; Patiño, 2020; Zepp et al., 2020; Huang et al., 2021). For example, in Cairo it is hard to find free public green space, and most parks are fenced and ticketed (Anderson et al., 2022). Another study shows the proximity to urban green areas in European cities is comparatively low but increases toward the rural space. In other words, the median proximity to urban green is about 13 times larger than to non-urban green (Wolff et al., 2020).

Buildings—as a shelter and a service provider- are crucial elements in the transition to a resilient city. Many bottom-up initiatives can be envisioned in the buildings sector, primarily rooted in sharing and circular economy; for example, participatory place-making and -keeping opportunities for marginalized groups, aiming for social integration, and community empowerment, and co-creating processes. Such initiatives also create opportunities from design for a more diverse society, that is to create new solidarities through housing and adaptable built environments that also contribute to the wellbeing of vulnerable citizens. Among the many ways to design for a more diverse and inclusive society and to create resilience and new solidarities through housing, the important role of cooperative projects, for example, social housing in Vienna, Helsinki, Amsterdam, and Copenhagen, is of particular relevance (Tsenkova, 2021; Kadi and Lilius, 2022; Kazepov and Verwiebe, 2022).

Transport infrastructure and choice architecture also serve as a frame in which mobility and other decisions happen. Changes in infrastructure provisioning can act as a **nudge** that makes people take different decisions by altering the decision-making procedure. In urban transport, some studies indicate that changes in infrastructure provision for active travel may contribute to the **uptake** of more walking and cycling (Frank et al., 2019). Flooding incidents in cities worldwide have exposed the vulnerability of

transport networks and the resulting significant, lasting disruption. This appears to be overlooked in emerging-coastal cities, especially prone to flooding, as plans for transport development are still largely being driven by economic considerations and uncontrolled urbanization (Duy et al., 2019).

Institutions

Climate change discloses fault lines of poverty, inequality, weak governance, and inadequate infrastructure. Conversely, studies show that inclusive governance and institutional capacity are key enablers for cities to adapt to and mitigate climate change. Policy contributes to shaping demand for services, travel and mobility, and given the range of activities, the policy agenda involves reaching out to a wide range of actors that includes practitioners and the general public. Therefore, a systematic deployment of effective regulatory and enforcement frameworks is required, which consists of regulations, market-based instruments, information-based instruments, and voluntary agreements at various governance levels to address a wide range of stakeholders and their concerns.

Participatory governance

Transparent multilevel and inclusive governance, improved institutional capacity, access to affordable finance, and behavioral change are necessary enabling conditions for climate responses, risk reduction, and mitigation. Transformation to climate-resilient cities is enabled only when governments, civil society, and businesses, with the support of scientists, make development choices that prioritize risk reduction, equity, inclusion, and justice. For example, a study that explores a successful case for engaging disadvantaged populations in Seattle-USA, highlights how traditional neighborhood planning approaches were replaced by employing "trusted advocates" who serve as planning outreach liaisons that connect local government with people of color, immigrants, refugees, the elderly, and others. The liaisons are indigenous to different groups, trusted and respected. Research has found that the "trusted advocates" model offers promise in improving transparency of local government intentions, facilitating communication of information, and coevolving solutions that fit the needs of marginalized neighborhoods (Oshun et al., 2011).

Ways forward

Cities play an important role in climate change, biodiversity loss, human wellbeing, and the relationships between them. The preceding discussion highlights the essential elements required to realize human-centered climate-resilient development and the importance of the interconnection between the three elements of agents, systems and institutions. Coastal cities are highly integrated systems that amplify the interplay between urban and natural/climate systems. They are, therefore, particularly vulnerable but also provide significant opportunities to achieve multiple objectives when integrated approaches are taken. Keeping in mind that there is a need for more studies on coastal cities in the Global South, here we conclude with recommendations emerging from the literature discussed previously for two areas where such integration can prove to be particularly impactful.

Overcoming mitigation-adaptation-resilience dichotomies

A growing literature recognizes the importance of aligning adaptation planning with overall city development and the significant potential co-benefits with climate mitigation actions (Thornbush et al., 2013; Lee et al., 2020; Boyd et al., 2022). Yet, this research also reveals the considerable barriers to mainstreaming a focus on climate mitigation co-benefits in city adaptation, development, and resilience planning. There are, however, significant benefits to redesigning policies to harness synergies across actions adaptive to support current needs, that mitigate to avoid future adaptation needs, and build resilience by taking a proactive human-centered, longer time-horizon, and iterative learning systems perspective. Recent literature highlights successful coastal city cases, e.g., Durban, Cape Town, London, and Vancouver, where synergistic and strategic adaptation and mitigation planning could deliver near-term benefits (Boyd et al., 2022). In addition, examples from research presented in the previous section (e.g., cooperative projects in Vienna, Helsinki, Amsterdam, and Copenhagen) showcase important ways in which this is being achieved and suggest that efforts to enhance such initiatives more widely would be worthwhile. In particular, to secure liveable and climate-resilient coastal cities, inclusive, equitable and actor-orientation in policies is needed. This includes individual and collective behavioral and lifestyle changes, political commitment, inclusive governance and integration across actors and sectors. Strengthening adaptation measures benefits vulnerable coastal cities and can reduce -but not eliminate all- losses and damages. At the same time, mitigation actions benefit from avoiding future damages and reduce future adaptation costs but entail higher up-front investment costs. Resilience planning strives to transform coastal cities and raise their ability to respond systemically and dynamically to present and future shocks and global challenges including unsustainable development patterns, rapid and *ad hoc* urbanization, climate change, and inequalities (Brunetta and Caldarice, 2020). Forging synergies among adaptation, mitigation and resilience planning can benefit from actor-oriented approaches in addition to the traditional focus on infrastructures and technologies.

Multiscalar governance for cross-sectoral and cross-agent coordination

Much of the research discussed here emphasizes the critical role of the governance context for coastal cities. Addressing climate change and improving human wellbeing requires an inclusive, equitable and all-of-society approach. Studies show that national policies together with solid institutions—which empower multi-scalar governance and local-level initiatives—enable coastal cities to

take action. Several governments have been investing in this system and strongly rely on their recommendation, namely, the London Climate Change Committee and the Trusted Advocates project in Seattle. The choices and actions we take now will have impacts for thousands of years. Multi-level governance and effective institutions can enable mitigation and adaptation strategies by prioritizing inclusive decision-making, enhancing equitable access to finance, infrastructure and technology, setting targets and priorities, and mainstreaming climate actions across sectors and actors. Immediate transitions across all sectors and systems that prioritize equity, social justice, and inclusion are needed to achieve mitigation and adaptation outcomes that shift pathways toward climate-resilient cities. While climate policy support is influenced by actors in civil society, business, youth, women, indigenous people, and local communities, policy effectiveness is enhanced by and requires political commitments, national and international partnerships, and cooperation.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

Both authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Alberti, M., Marzluff, J. M., Shulenberger, E., Bradley, G., Ryan, C., and Zumbrunnen, C. (2003). Integrating humans into ecology: opportunities and challenges for studying urban ecosystems. *BioScience* 53, 1169–1179. doi: 10.1641/0006-3568(2003)053[1169:IHIEOA]2.0.CO;2

Anderson, B., Quinchía, J. E. P., and Curiel, R. P. (2022). *Boosting African Cities' Resilience to Climate Change: The Role of Green Spaces*. Paris: OECD.

Aram, F., Higueras García, E., Solgi, E., and Mansournia, S. (2019). Urban green space cooling effect in cities. *Heliyon* 5, e01339. doi: 10.1016/j.heliyon.2019.e01339

Barragán, J. M., and de Andrés, M. (2015). Analysis and trends of the world's coastal cities and agglomerations. *Ocean Coast. Manag.* 114, 11–20. doi: 10.1016/j.ocecoaman.2015.06.004

Berke, P., Yu, S., Malecha, M., and Cooper, J. (2019). Plans that disrupt development: equity policies and social vulnerability in six coastal cities. *J. Plan. Educ. Res.* 42, 0739456X19861144. doi: 10.1177/0739456X19861144

Boyd, D., Pathak, M., van Diemen, R., and Skea, J. (2022). Mitigation co-benefits of climate change adaptation: a case-study analysis of eight cities. *Sustain. Cities Soc.* 77, 103563. doi: 10.1016/j.scs.2021.103563

Brown, K. (2014). Global environmental change I: a social turn for resilience? *Prog. Hum. Geogr.* 38, 107–117. doi: 10.1177/0309132513498837

Brunetta, G., and Caldarice, O. (2020). "Spatial resilience in planning: meanings, challenges, and perspectives for urban transition," in *ustainable Cities and Communities*, eds W. Leal Filho, A. Marisa Azul, L. Brandli, P. Gökçin Özuyar, and T. Wall (New York, NY: Springer International Publishing), 628–640. doi: 10.1007/978-3-319-95717-3_28

Bukvic, A., Rohat, G., Apotsos, A., and de Sherbinin, A. (2020). A systematic review of coastal vulnerability mapping. *Sustainability* 12, 7. doi: 10.3390/su12072822

Chen, Y., Yue, W., and La Rosa, D. (2020). Which communities have better accessibility to green space? An investigation into environmental inequality using big data. *Landsc. Urban Plan.* 204, 103919. doi: 10.1016/j.landurbplan.2020.103919

Creutzig, F., Niamir, L., Bai, X., Callaghan, M., Cullen, J., Díaz-Jos,é, J., et al. (2022a). Demand-side solutions to climate change mitigation consistent with high levels of wellbeing. *Nat. Clim. Change* 12, 36–46. doi: 10.1038/s41558-021-01219-y

Creutzig, F., Roy, J., Devine-Wright, P., Díaz-Jos,é, J., Geels, F. W., Grubler, A., et al. (2022b). "Demand, services and social aspects of mitigation," in *IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge: Cambridge University Press).

Duy, P. N., Chapman, L., and Tight, M. (2019). Resilient transport systems to reduce urban vulnerability to floods in emerging-coastal cities: A case study of Ho Chi Minh City, Vietnam. *Travel. Behav. Soc.* 15, 28–43. doi: 10.1016/j.tbs.2018.11.001

Ekkel, E. D., and de Vries, S. (2017). Nearby green space and human health: evaluating accessibility metrics. *Landsc. Urban Plan.* 157, 214–220. doi: 10.1016/j.landurbplan.2016.06.008

Filho, W. L., Balogun, A.-L., Olayide, O. E., Azeiteiro, U. M., Ayal, D. Y., Muñoz, P. D. C., et al. (2019). Assessing the impacts of climate change in cities and their adaptive capacity: towards transformative approaches to climate change adaptation and poverty reduction in urban areas in a set of developing countries. *Sci. Total Environ.* 692, 1175–1190. doi: 10.1016/j.scitotenv.2019.07.227

Folke, C. (2006). Resilience: the emergence of a perspective for social–ecological systems analyses. *Glob. Environ. Change* 16, 253–267. doi: 10.1016/j.gloenvcha.2006.04.002

Frank, L. D., Hong, A., and Ngo, V. D. (2019). Causal evaluation of urban greenway retrofit: a longitudinal study on physical activity and sedentary behavior. *Prevent. Med.* 123, 109–116. doi: 10.1016/j.ypmed.2019.01.011

Fraser, T. (2022). Fleeing the unsustainable city: soft policy and the dual effect of social capital in hurricane evacuation. *Sustain. Sci.* 17, 1995–2011. doi: 10.1007/s11625-022-01098-y

Haskell, L., Bonnedahl, K. J., and Ståhl, H. I. (2021). Social innovation related to ecological crises: a systematic literature review and a research agenda for

strong sustainability. *J. Clean. Prod.* 325, 129316. doi: 10.1016/j.jclepro.2021.129316

Howell, J., and Elliott, J. R. (2019). Damages done: the longitudinal impacts of natural hazards on wealth inequality in the United States. *Soc. Probl.* 66, 448–467. doi: 10.1093/socpro/spy016

Huang, C., Yang, J., Clinton, N., Yu, L., Huang, H., Dronova, I., et al. (2021). Mapping the maximum extents of urban green spaces in 1039 cities using dense satellite images. *Environ. Res. Lett.* 16, 064072. doi: 10.1088/1748-9326/ac03dc

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Kadi, J., and Lilius, J. (2022). The remarkable stability of social housing in Vienna and Helsinki: a multi-dimensional analysis. *Hous. Stud.* 14, 1–25. doi: 10.1080/02673037.2022.2135170

Kazepov, Y., and Verwiebe, R. (2022). *Vienna: Still a Just City?* New York, NY: Routledge. Available online at: https://www.routledge.com/Vienna-Still-a-Just-City/Kazepov-Verwiebe/p/book/9780367680114 (accessed January, 2022).

Le, T. D. N. (2020). Climate change adaptation in coastal cities of developing countries: characterizing types of vulnerability and adaptation options. *Mitigat. Adapt. Strateg. Global Change* 25, 739–761. doi: 10.1007/s11027-019-09888-z

Lee, T., Yang, H., and Blok, A. (2020). Does mitigation shape adaptation? The urban climate mitigation-adaptation nexus. *Clim. Policy* 20, 341–353. doi: 10.1080/14693062.2020.1730152

Meerow, S., and Newell, J. P. (2019). Urban resilience for whom, what, when, where, and why? *Urban Geogr.* 40, 309–329. doi: 10.1080/02723638.2016.1206395

Miguez, M. G., Veról, A. P., Battemarco, B. P., Yamamoto, L. M. T., de Brito, F. A., Fernandez, F. F., et al. (2019). A framework to support the urbanization process on lowland coastal areas: Exploring the case of Vargem Grande: Rio de Janeiro, Brazil. *J. Clean. Prod.* 231, 1281–1293. doi: 10.1016/j.jclepro.2019.05.187

Mont, O., Neuvonen, A., and Lähteenoja, S. (2014). Sustainable lifestyles 2050: Stakeholder visions, emerging practices and future research. *J. Clean. Prod.* 63, 24–32. doi: 10.1016/j.jclepro.2013.09.007

Niamir, L., Ivanova, O., and Filatova, T. (2020). Economy-wide impacts of behavioral climate change mitigation: linking agent-based and computable general equilibrium models. *Environ. Model. Softw.* 134, 104839. doi: 10.1016/j.envsoft.2020.104839

Noll, B., Filatova, T., Need, A., and Taberna, A. (2022). Contextualizing cross-national patterns in household climate change adaptation. *Nat. Clim. Change* 12, 1. doi: 10.1038/s41558-021-01222-3

Oshun, M., Ardoin, N. M., and Ryan, S. (2011). Use of the planning outreach liaison model in the neighborhood planning process: a case study in Seattle's rainier valley neighborhood. *Urban Stud. Res.* 2011, e687834. doi: 10.1155/2011/687834

Otto, I. M., Donges, J. F., Cremades, R., Bhowmik, A., Hewitt, R. J., Lucht, W., et al. (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. *Proc. Natl. Acad. Sci.* 117, 2354–2365. doi: 10.1073/pnas.1900577117

Patiño, J. E. (2020). "Analyzing long-term availability of urban green space by socioeconomic status in Medellin, Colombia, using open data and tools," in *Proceedings of the 2020 IEEE Latin American GRSS and ISPRS Remote Sensing Conference (LAGIRS)* (New York, NY: IEEE) 87–92. doi: 10.1109/LAGIRS48042.2020.9165672

Pel, B., Haxeltine, A., Avelino, F., Dumitru, A., Kemp, R., Bauler, T., et al. (2020). Towards a theory of transformative social innovation: a relational framework and 12 propositions. *Res. Policy* 49, 104080. doi: 10.1016/j.respol.2020.104080

Rangel-Buitrago, N., Neal, W. J., Bonetti, J., Anfuso, G., and de Jonge, V. N. (2020). Vulnerability assessments as a tool for the coastal and marine hazards management: an overview. *Ocean Coast. Manag.* 189, 105134. doi: 10.1016/j.ocecoaman.2020.105134

Rao, N. D., and Min, J. (2018). Decent living standards: material prerequisites for human wellbeing. *Soc. Indicat. Res.* 138, 225–244. doi: 10.1007/s11205-017-1650-0

Roy, J., Dowd, A. M., Muller, A., Pal, S., Prata, N., and Lemmet, S. (2012). "Chapter 21: Lifestyles, wellbeing and energy," in *Global Energy Assessment—Toward a Sustainable Future* (Cambridge: Cambridge University Press) 1527–1548. doi: 10.1017/CBO9780511793677.027

Sharifi, A. (2022). An overview and thematic analysis of research on cities and the COVID-19 pandemic: toward just, resilient, and sustainable urban planning and design. *IScience* 25, 105297. doi: 10.1016/j.isci.2022.105297

Spijker, S. N., and Parra, C. (2018). Knitting green spaces with the threads of social innovation in Groningen and London. *J. Environ. Plan. Manag.* 61, 1011–1032. doi: 10.1080/09640568.2017.1382338

Thomas, K., Hardy, R. D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., et al. (2019). Explaining differential vulnerability to climate change: a social science review. *WIREs Clim. Change* 10, e565. doi: 10.1002/wcc.565

Thornbush, M., Golubchikov, O., and Bouzarovski, S. (2013). Sustainable cities targeted by combined mitigation–adaptation efforts for future-proofing. *Sustain. Cit. Soc.* 9, 1–9. doi: 10.1016/j.scs.2013.01.003

Torabi, E., Dedekorkut-Howes, A., and Howes, M. (2018). Adapting or maladapting: building resilience to climate-related disasters in coastal cities. *Cities* 72, 295–309. doi: 10.1016/j.cities.2017.09.008

Tsenkova, S. (2021). "Resilience of social housing systems in Vienna, Amsterdam, and Copenhagen," in *Cities and Affordable Housing: Planning, Design and Policy Nexus, 1st edn* (New York, NY: Routledge), 23. doi: 10.4324/9781003172949-1

Tyler, S., and Moench, M. (2012). A framework for urban climate resilience. *Clim. Dev.* 4, 311–326. doi: 10.1080/17565529.2012.745389

UNESCO, IOC, FAO, UNDP, and IMO (2011). *A Blueprint for Ocean and Coastal Sustainability: An Inter-Agency Paper Towards the Preparation of the UN Conference on Sustainable Development (Rio 20)*. Paris: UNESCO. Available online at: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/interagency_blue_paper_ocean_rioPlus20.pdf (accessed December, 2021).

Wolch, J. R., Byrne, J., and Newell, J. P. (2014). Urban green space, public health, and environmental justice: the challenge of making cities 'just green enough. *Landsc. Urban Plan.* 125, 234–244. doi: 10.1016/j.landurbplan.2014.01.017

Wolff, M., Scheuer, S., and Haase, D. (2020). Looking beyond boundaries: revisiting the rural-urban interface of green space accessibility in Europe. *Ecol. Indicat.* 113, 106245. doi: 10.1016/j.ecolind.2020.106245

Wu, J., Peng, Y., Liu, P., Weng, Y., and Lin, J. (2022). Is the green inequality overestimated? Quality reevaluation of green space accessibility. *Cities* 130, 103871. doi: 10.1016/j.cities.2022.103871

Zepp, H., Gro,ß, L., and Inostroza, L. (2020). And the winner is? Comparing urban green space provision and accessibility in eight European metropolitan areas using a spatially explicit approach. *Urban For. Urban Greening* 49, 126603. doi: 10.1016/j.ufug.2020.126603

Ziervogel, G., and Taylor, A. (2008). Feeling stressed: integrating climate adaptation with other priorities in South Africa. *Environ. Sci. Policy Sustain. Dev.* 50, 32–41. doi: 10.3200/ENVT.50.2.32-41

Žlender, V., and Ward Thompson, C. (2017). Accessibility and use of peri-urban green space for inner-city dwellers: a comparative study. *Landsc. Urban Plan.* 165, 193–205. doi: 10.1016/j.landurbplan.2016.06.011